This table confirms that the fauna of Aden contains both species and real intermediates.

Note: Mr. Lander found true Cypraea tigris at Tarshyne Point only, and the hybrids seem to be restricted to the same area, whereas typical C. pantherina have been collected also in remote areas of the Aden region: the material is still too scanty, but it seems to point to the local genetic influence of C. tigris. The dwarf C. pantherina catulus may live in a very restricted place not yet detected by Mr. Lander.

Summary

Cypraea tigris Linnaeus, 1758, and C. pantherina Solander, 1786, are well separable if they come from regions where only one species lives; in the Gulf of Aden, however, where both species occur in the same place, one can observe intermediate shells of various degrees which should be interpreted as hybrids.

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Preliminary Report on Time Elements involved in Hydrotropism in *Helix aspersa* (Gastropoda : Pulmonata) Following Dehydration

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(3 Textfigures)

It has long been known that certain terrestrial animals tend to accumulate either in dry or wet areas. The terrestrial snail Helix aspersa is of the first type. Under dry conditions this animal will go into a state of dormancy, which may be changed to a state of activity upon moistening the animal or upon the introduction of water to its immediate area (Tryon, 1882).

One adaptive mechanism in some animals is a behavioral tendency to select a region of optimum humidity. In arthropods there is an optimal humidity for various species, and such functions as reproductive rate, rate of individual development, proportion of individuals maturing are increased under optimal humidity conditions (Ludwig, 1945). African migratory locusts prefer dry air to wet air (Kennedy, 1937) and a similar preference is found in the mealworm beetle (Gunn and Pielow, 1940). Cockroaches have a mixed reaction to a humidity gradient, but they become more hygropositive when desiccated (Gunn and Cosway, 1938). The wood

louse is active in dry air and becomes almost motionless in nearly saturated air (Gunn, 1937), and Ptinus tectus Boie shows increased locomotor activity with an increase in humidity (Bentley, 1944). In a study of terrestrial isopods it was observed that the animals congregated in moist areas due to a decrease in activity and an increase in turning (Waloff, 1941). Preferences for water-saturated soil and for moist but air-filled soil were observed in some species of earthworms (Roots, 1956). One species of wireworm will migrate from dry to wet soil (Lees, 1943a) and will avoid dry air (Lees, 1943b). A review of the reactions of insects to humidity changes was presented by Dethier and Chadwick (1948).

The following experiments were designed to furnish numerical data concerning hydrotropism in the terrestrial snail Helix aspersa after the animals had been experimentally dehydrated.

Materials & Methods

Three groups of animals were used.

Group I consisted of 130 specimens of Helix aspersa placed in a box 27½ cm. high, 55 cm. long and 40 cm. wide. The top was covered by aluminum screening. The bottom of the box contained about 5 cm. of dry soil, on which food was placed as required. No water was supplied to these animals, nor was the soil moistened at any time. The animals were kept as above from May 12, 1960 to June 9, 1960 by which time all animals had sealed themselves off on the wooden sides of the box.

On June 9, 1960 a round dish with a diameter of 17 cm. and a depth of 4 cm. was filled with water to half its height and placed in the center of the wooden box. A comparable dish without water was placed in the box as a control. It was the purpose of this experiment to determine how long it would take the snails to cease estivating and reach the water. The box and dishes were observed several times each day and night. Snails found at the water dish were marked with blue nail polish on the apex of the spire, thus permitting identification of those snails which had reached the dish. In this manner it was possible to avoid counting the same animal more than once and to permit a count of the total number of animals which reached the water dish during the experimental period.

Group II consisted of 50 snails which were kept dry in a large glass jar until they went into a state of dormancy. The spires of 25 were marked with red nail polish and 25 with blue nail polish and they were then placed in a wooden box 45 cm. by 45 cm., with a height of 4 cm. exclusive of 4 cm. of soil in the bottom of the box. A wooden divider, reaching from the bottom of the box to the aluminum screening covering the top of the box, was placed in its exact center in a manner which would divide the box into halves. A gap of 7½ cm. was left at one end of the divider, giving the snails access from one side of the box to the other through this opening.

One side of the box was left entirely dry and the other half was kept constantly wet. Adequate amounts of food were supplied equally to both sides. The animals with red markings were placed on the dry side in the corner farthest from the passageway between the dry and wet sides; the animals with blue markings were placed on the wet side of the box in the comparable corner. The animals were observed daily and the numbers of red and blue marked snails found on the two sides were recorded. This experiment lasted from May 29, 1960 to June 14, 1960, at which date some animals accidentally escaped from the box.

Group III consisted of 50 animals housed and treated exactly as were the animals in Group II. The only difference between this group and Group II is that after most of the animals had gone over to the wet side, the formerly dry side was made wet and the original wet side was permitted to dry out. This experiment ran from June 15, 1960 to July 4, 1960.

Results

Group I. It was found that approximately 24 hours were required before the first animal ceased being dormant and reached the water dish. Thus the water dish placed in the box at 9 P. M. on June 9, 1960 was reached by the first snail at 9:30 P. M. on June 10. From that time on a successively larger number of snails ceased estivating each day and reached the water dish. Figure 1 shows the day by day increment over a period of 35 days. Most of this activity took place during the hours of darkness. The dry control dish did not attract any animals.

The container in which the Group I animals were housed was too small to permit valid observations concerning the effects of distance from water on the time required to arouse the animals. Within the limits of the space used we observed no differences in time of arousal in animals closer or farther from the water dish.

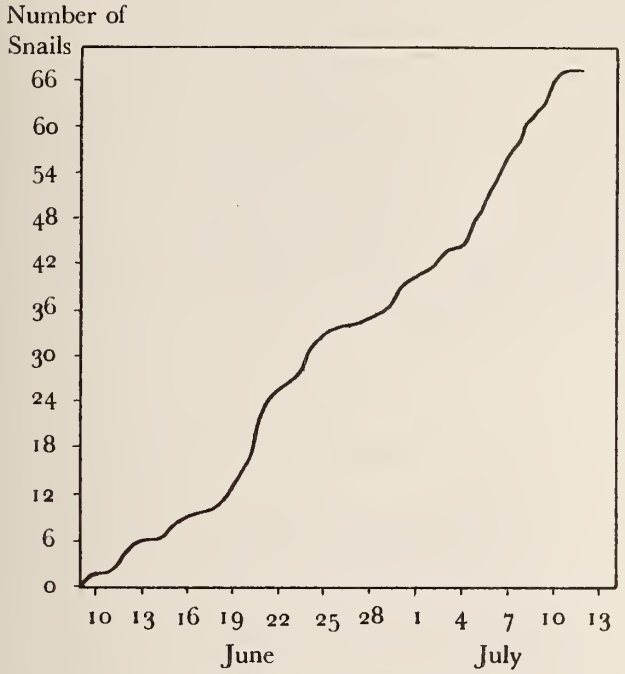

Figure 1: Graph showing the day by day increment in the numbers of animals ceasing estivation and becoming active in the presence of a dish of water (Group 1)

Group II. It was observed that the animals from both sides tended to travel back and forth from one side to the other. On the whole, however, the tendency was for all animals, regardless of the side on which they were originally placed, to concentrate on the wet side. The largest number of animals concentrated on each side during each day of the experiment is shown graphically in Figure 2. The initial tendency to move from the dry side to the wet side was observed ten hours after the beginning of the experiment.

Group III. It took ten days for 49 of the 50 animals to concentrate on the wet side. When the wet side was permitted to become dry and the original dry side was made wet it took 9 days for 49 animals to congregate on the new wet side. The largest number of animals concentrated on each side during each day of the experiment is shown graphically in Figure 3. In this group, as in Group II, the tendency to move from the dry side to the wet side was observed within less than 12 hours after the experiment started.

Discussion

It has long been known that Helix aspersa will seek moist areas in preference to dry ones when a choice is available. The mechanism by

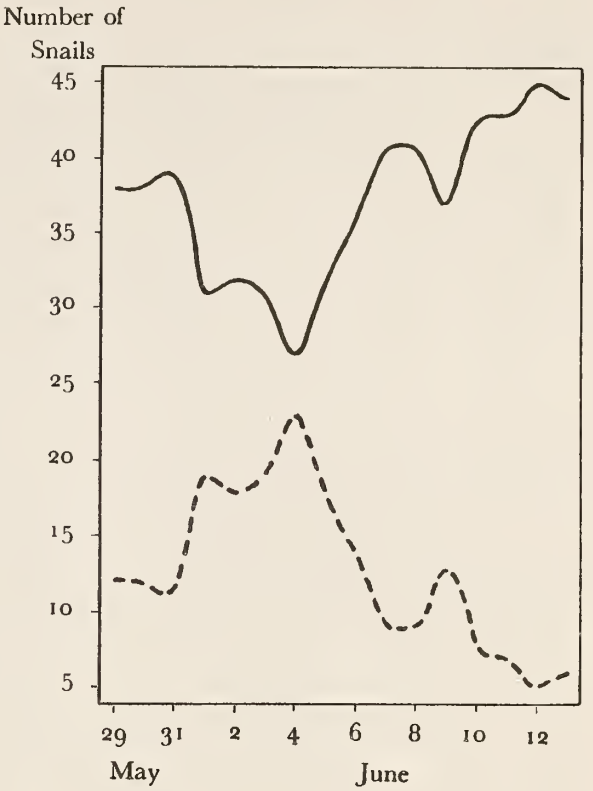

Figure 2: Solid line: number of snails migrating from the dry soil to the wet soil. Broken line: number of snails remaining on the dry side at any given time (Group 2)

which this is done is not apparent from these data, but the time intervals involved in ceasing estivation and reaching water are clear. This animal is able to detect moisture from the induced dormant state and will reach the moisture in a short period of time. The behavior of the animal may be experimentally varied by subjecting it to alternate wet and dry environments, and the time required for the beginning of activity and its subsequent continuation may be measured.

The results of these experiments suggest other likely procedures designed to furnish additional data on hydrotropism in Helix aspersa. The effects of relative humidity on the arousal of dormant snails could shed light on the mechanism of arousal. The manner of finding water after arousal could be studied as a possible separate physiologic process. The effect of distance from water on the arousal process will be studied by us in an effort to determine whether a critical distance exists beyond which the presence of water fails to arouse the animals, and to observe any differences existing in arousal time in animals placed at various distances from water within the probable critical distance.

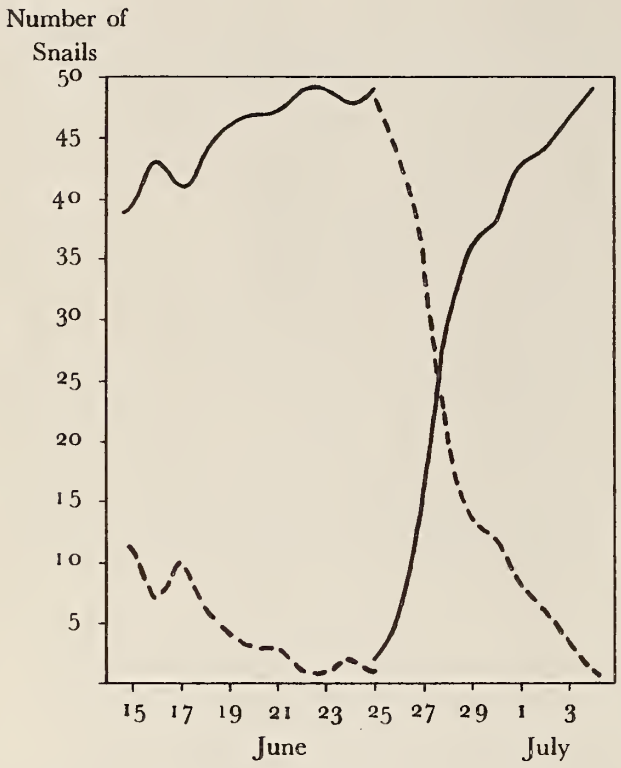

Figure 3: Solid line on the left: number of snails migrating from dry to wet soil. Solid line on the right: number of snails migrating when wet and dry soils were reversed. Broken lines: number of snails on the dry side at any given time
(Group 3)

Summary

Three experiments are described in which specimens of Helix aspersa indicated their ability to awaken from an induced dormant state when moisture became available to them. The animals reached moisture within a day after being exposed to its presence.

Animals given a choice between wet and dry soil congregated in the moist area within ten days.

When the positions of wet and dry soil were reversed the animals moved to the new wet soil from the new dry soil within nine days.

ABSTRACT

Two hundred and thirty specimens of Helix aspersa were subjected to three experimental procedures for the purpose of studying their ability to react to the presence of moisture during their dormant state. It was found that it took one day for the first dormant snails to reach water after which time successively larger numbers reached it daily. The first snails left dry soil and reached wet soil in twelve hours or less and virtually all animals in the two groups studied reached wet soil over a period of ten days. When the dry and wet soils were reversed the now non-dormant snails reached the new wet soil in nine days.

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